

1. A dental restorative composition comprising:

a polymerizable, ethylenically unsaturated resin composition;

a filler composition comprising a modified polyhedral oligomeric silsesquioxane filler; and

a curing system.
2. The composition of claim 1, wherein the resin composition comprises an acrylate or methacrylate resin.
3. The composition of claim 2, wherein the resin composition further comprises 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, ethylene glycol methacrylate, diethylene glycol methacrylate, tri(ethylene glycol) dimethacrylate, tetra(ethylene glycol) dimethacrylate, butanedioldimethacrylate, dodecanedioldimethacrylate, 1,6-hexanedioldimethacrylate, or a mixture comprising at least one of the foregoing methacrylate monomers.
4. The composition of claim 1, wherein the resin composition comprises polyurethane dimethacrylate, diurethane dimethacrylate, polycarbonate dimethacrylate, ethoxylated bisphenol A dimethacrylate, 2,2'-bis [4-(3-methacryloxy-2-hydroxy propoxy)-phenyl]-propane, or a mixture comprising at least one of the foregoing resins.
5. The composition of claim 1, wherein the modified polyhedral oligomeric silsesquioxane filler comprises at least one functional group reactive with the resin composition.

6. The composition of claim 5, wherein the reactive group comprises halide, alcohol, amine, isocyanate, acid, acid chloride, silanol, silane, acryl, methacryl, olefin, epoxy, or a mixture comprising at least one of the foregoing reactive groups.

7. The composition of claim 5, wherein the reactive group comprises an acryl or methacryl.

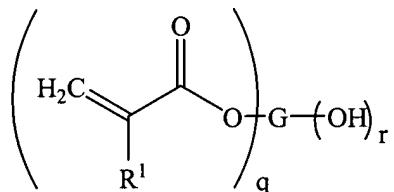
8. The composition of claim 5, wherein the reactive group comprises an alkoxy silane, a styrene, an olefin, an epoxy, a chlorosilane, an amine, an alcohol, a phenol, a phosphine, a norbornenyls, a nitrile, an isocyanate, a halide, an ester, or a mixture comprising at least one of the foregoing reactive groups.

9. The composition of claim 1, wherein the modified polyhedral oligomeric silsesquioxane filler is the reaction product of

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_7T_4D_3(OY)_3$, wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; Y is an organic group comprising an epoxy functional group; or

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_n-T_nY_m$ wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; n is 6, 8, 10, or 12; m is 1 to n; T is SiO_{1.5}; and Y is an organic group comprising an epoxy functional group; and

a (meth)acrylic acid, or a hydroxy (meth)acrylate of the formula



wherein q and r are independently integers from 1 to 6; G is a substituted or unsubstituted C₁-C₃₃ alkyl, substituted or unsubstituted aryl group, or (C₁-C₆) alkyl-oxy-(C₁-C₆) alkyl; and R¹ is hydrogen or methyl, wherein the substitution is linear or branched, saturated or unsaturated C₁-C₁₂ alkyl; C₁-C₁₂ alkoxy; cyclic C₃-C₇ alkyl; halogens; ester groups; ether groups; amide groups; aryl; or a combination comprising at least one of the foregoing substitutions.

10. The composition of claim 1, wherein the modified polyhedral oligomeric silsesquioxane filler is the reaction product of

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_7T_4D_3(OY)_3$, wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; Y is an organic group comprising a hydroxy functional group, a phenol functional group, or a carboxyl functional group; or

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_n \cdot T_m Y_m$ wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; n is 6, 8, 10, or 12; m is 1 to n; T is SiO_{1.5}; and Y is an organic group comprising a hydroxy functional group, a phenol functional group, or a carboxyl functional group; and

a compound comprising both (meth)acrylate functionality and epoxy functionality.

11. The composition of claim 1, wherein the composition further comprises a polyhedral oligomeric silsesquioxane filler.

12. The composition of claim 1, wherein the filler composition further comprises fumed silica, colloidal silica, aluminosilicate glass, fluoroaluminosilicate glass, silica, quartz, strontium silicate, strontium borosilicate, lithium silicate, lithium alumina silicate, amorphous silica, ammoniated or deammoniated calcium phosphate, alumina, zirconia, tin oxide, titania, or a mixture comprising at least one of the foregoing fillers.

13. A method for the production of a dental restoration, comprising applying the composition of claim 1 to a site on a tooth to be restored; and curing the composition.

14. The method of claim 13, wherein the resin composition comprises an acrylate or methacrylate resin.

15. The method of claim 13, wherein the resin composition comprises polyurethane dimethacrylate, diurethane dimethacrylate, polycarbonate dimethacrylate, ethoxylated bisphenol A dimethacrylate, 2,2'-bis [4-(3-methacryloxy-2-hydroxy propoxy)-phenyl]-propane, or a mixture comprising at least one of the foregoing resins.

16. The method of claim 15, wherein the resin composition further comprises 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, ethylene glycol methacrylate, diethylene glycol methacrylate, tri(ethylene glycol) dimethacrylate, tetra(ethylene glycol) dimethacrylate, butanedioldimethacrylate, dodecanedioldimethacrylate, 1,6-hexanedioldimethacrylate, or a mixture comprising at least one of the foregoing methacrylate monomers.

17. The method of claim 13, wherein the modified polyhedral oligomeric silsesquioxane filler comprises at least one functional group reactive with the resin composition.

18. The method of claim 17, wherein the reactive group comprises halide, alcohol, amine, isocyanate, acid, acid chloride, silanol, silane, acryl, methacryl, olefin, epoxy, or a mixture comprising at least one of the foregoing reactive groups.

19. The method of claim 17, wherein the reactive group comprises an acryl or methacryl.

20. The method of claim 17, wherein the reactive group comprises an alkoxysilane, a styrene, an olefin, an epoxy, a chlorosilane, an amine, an alcohol, a phenol, a phosphine, a norbornenyls, a nitrile, an isocyanate, a halide, an ester, or a mixture comprising at least one of the foregoing reactive groups.

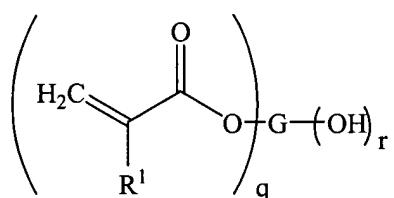
21. The method of claim 13, wherein the modified polyhedral oligomeric silsesquioxane filler is the reaction product of

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_7T_4D_3(OY)_3$, wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; Y is an organic group comprising an epoxy functional group;

or

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_n-T_mY_m$ wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; n is 6, 8, 10, or 12; m is 1 to n; T is SiO_{1.5}; and Y is an organic group comprising an epoxy functional group; and

a (meth)acrylic acid, or a hydroxy (meth)acrylate of the formula



wherein q and r are independently integers from 1 to 6; G is a substituted or unsubstituted C₁-C₃₃ alkyl, substituted or unsubstituted aryl group, or (C₁-C₆) alkyl-oxy-(C₁-C₆) alkyl; and R¹ is hydrogen or methyl, wherein the substitution is linear or branched, saturated or unsaturated C₁-C₁₂ alkyl; C₁-C₁₂ alkoxy; cyclic C₃-C₇ alkyl; halogens; ester groups; ether groups; amide groups; aryl; or a combination comprising at least one of the foregoing substitutions.

22. The method of claim 13, wherein the modified polyhedral oligomeric silsesquioxane filler is the reaction product of

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_7T_4D_3(OY)_3$, wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; Y is an organic group comprising a hydroxy functional group, a phenol functional group, or a carboxyl functional group; or

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_n \cdot {}_m T_n Y_m$ wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; n is 6, 8, 10, or 12; m is 1 to n; T is SiO_{1.5}; and Y is an organic group comprising a hydroxy functional group, a phenol functional group, or a carboxyl functional group; and

a compound comprising both (meth)acrylate functionality and epoxy functionality.

23. The method of claim 13, wherein the composition further comprises a polyhedral oligomeric silsesquioxane filler.

24. The method of claim 13, wherein the filler composition further comprises fumed silica, colloidal silica, aluminosilicate glass, fluoroaluminosilicate glass, silica, quartz, strontium silicate, strontium borosilicate, lithium silicate, lithium alumina silicate, amorphous silica, ammoniated or deammoniated calcium phosphate, alumina, zirconia, tin oxide, titania, or a mixture comprising at least one of the foregoing fillers.

25. A dental restoration, comprising the cured composition of claim 1.

26. The restoration of claim 25, wherein the resin composition comprises an acrylate or methacrylate resin.

27. The restoration of claim 25, wherein the resin composition comprises polyurethane dimethacrylate, diurethane dimethacrylate, polycarbonate dimethacrylate, ethoxylated bisphenol A dimethacrylate, 2,2'-bis [4-(3-methacryloxy-2-hydroxy propoxy)-phenyl]-propane, or a mixture comprising at least one of the foregoing resins.

28. The restoration of claim 27, wherein the resin composition further comprises 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, ethylene glycol methacrylate, diethylene glycol methacrylate, tri(ethylene glycol) dimethacrylate, tetra(ethylene glycol) dimethacrylate, butanedioldimethacrylate, dodecanedioldimethacrylate, 1,6-hexanedioldimethacrylate, or a mixture comprising at least one of the foregoing methacrylate monomers.

29. The restoration of claim 25, wherein the modified polyhedral oligomeric silsesquioxane filler is the reaction product of

a polyhedral oligomeric silsesquioxane monomer according to the formula

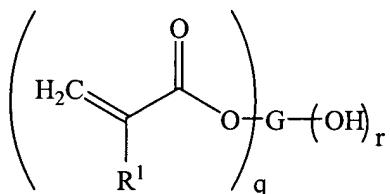
$R_7T_4D_3(OY)_3$, wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; Y is an organic group comprising an epoxy functional group;

or

a polyhedral oligomeric silsesquioxane monomer according to the formula R_n.

$_mT_nY_m$ wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; n is 6, 8, 10, or 12; m is 1 to n; T is SiO_{1.5}; and Y is an organic group comprising an epoxy functional group; and

a (meth)acrylic acid, or a hydroxy (meth)acrylate of the formula



wherein q and r are independently integers from 1 to 6; G is a substituted or unsubstituted C₁-C₃₃ alkyl, substituted or unsubstituted aryl group, or (C₁-C₆) alkyl-oxy-(C₁-C₆) alkyl; and R¹ is hydrogen or methyl, wherein the substitution is linear or branched, saturated or unsaturated C₁-C₁₂ alkyl; C₁-C₁₂ alkoxy; cyclic C₃-C₇ alkyl; halogens; ester groups; ether groups; amide groups; aryl; or a combination comprising at least one of the foregoing substitutions.

30. The restoration of claim 25, wherein the modified polyhedral oligomeric silsesquioxane filler is the reaction product of

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_7T_4D_3(OY)_3$, wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; Y is an organic group comprising a hydroxy functional group, a phenol functional group, or a carboxyl functional group; or

a polyhedral oligomeric silsesquioxane monomer according to the formula $R_n-T_nY_m$ wherein R is C₁-C₂₄ straight, branched, or cyclic alkyl, C₁-C₂₄ aromatic, alkylaryl, or arylalkyl, wherein the alkyl or aromatic is optionally substituted with C₁-C₆ alkyl, halo, C₁-C₆ alkoxy, C₁-C₆ perhaloalkyl, or a combination comprising at least one of the foregoing substitutions; n is 6, 8, 10, or 12; m is 1 to n; T is SiO_{1.5}; and Y is an organic group comprising a hydroxy functional group, a phenol functional group, or a carboxyl functional group; and

a compound comprising both (meth)acrylate functionality and epoxy functionality.

31. A dental restorative composition comprising:
 - a modified polyhedral oligomeric silsesquioxane resin; and
 - a curing system.
32. The composition of claim 31, further comprising a filler composition.
33. The composition of claim 32, wherein the filler composition comprises a modified polyhedral oligomeric silsesquioxane filler.
34. The composition of claim 33, wherein the filler composition further comprises fumed silica, colloidal silica, aluminosilicate glass, fluoroaluminosilicate glass, silica, quartz, strontium silicate, strontium borosilicate, lithium silicate, lithium alumina silicate, amorphous silica, ammoniated or deammoniated calcium phosphate, alumina, zirconia, tin oxide, titania, or a mixture comprising at least one of the foregoing fillers.
35. The composition of claim 31, further comprising a polymerizable, ethylenically unsaturated resin composition.